PATENT SPECIFICATION

1,025,492

1,025,492

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Int. Cl.:—B 44 d // C23c.

COMPLETE SPECIFICATION

DRAWINGS ATTACHED

Coating Process and Apparatus

I, MILLARD FILLMORE SMITH, a citizen of the United States of America, of 2, Harding Lane, Westport, Connecticut, United States of America, do hereby declare the invention, for which I pray that a patent may be granted to me, and the method by which it is to be performed, to be particularly described in and by the following statement:—

This invention relates to a coating technique and apparatus. More particularly, the invention relates to a method of and apparatus for coating certain specific portions of an article using a spray of powdered material.

Presently-known coating techniques are of various types. Those which appear to be the most closely allied to the technique of this invention are (1) fluidized bed coating, (2) cold spray coating, and (3) liquid or semi-plastic spray coating.

In fluidized bed coating, the article to be coated is first heated above the melting point range of the plastic material being used to coat the article. It is then immersed, for a few seconds, into a fluidized bed of particles of said plastic material. Some of the particles stick to the immersed article. Upon removal, the residual heat melts and levels the adhering particles to a smooth, non-porous plastic coat. The advantages of this technique are that it eliminates the need for solvent, a thick coat can be built up by successive dips, and the coating formed is substantially uniform throughout the entire surface of the article. The latter occurs because the scrubbing, turbulent action of the fluidized bed causes particles to reach the most recessed areas of the item being coated. There is very little material loss.

In cold spray coating, the object to be coated is similarly preheated, but here powdered plastic material is sprayed directly onto the object. Upon contacting the hot surface of the object, the plastic material melts and forms a smooth, substantially continuous coating thereon. The coating may be subsequently "polished" by a post-heating step.

A variation of this technique involves spraying the powdered coating material through a flame prior to impingement onto the surface of the object. Thus, when the powder hits, it is already molten and has a fairly high kinetic energy, increasing the adhesion and also smoothing the coating. This particular technique is attractive because it obviates the need for a fluidizing vessel and permits on-site application.

In liquid or semi-plastic spray coating, the coating material is first liquified or converted to a semi-plastic particulate state. It is then blown upon a base surface. In most instances, the formed coat is subsequently stripped off the base surface. Frequently, where the base surface is porous, a suction is provided opposite the spray nozzle to aid in uniform deposition. Although this technique has been included here, it basically is designed for film or sheet forming and has, at most, only limited utility as a coating technique, the basic reason for this being the lack of control over the application of the blown stream of plastic material, especially where a suction is not, or cannot be, provided.

In all of the above techniques, free application of the coating material occurs; that is, unless some sort of physical masking is employed, the entire surface of the article will be coated to some extent. Since masking involves a large amount of hand or machine labor, these techniques are not economically adaptable to the coating of parts only of an article such as a stator or

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rotor of an electric motor.

Accordingly, a principal object of this invention is to provide a novel method and apparatus, employing a particulate fusible material, for partially coating an article without physical masking.

From one aspect, the invention consists in a method for coating a specific surface area of an article with a particulate fusible coating material whilst another surface area is left uncoated, which comprises directing toward the specific surface areas to be coated a stream of fluidized particules of the fusible material, depositing the fusible material on the specific area, and subjecting the area to be left uncoated to an exhaust stream, whereby material that would otherwise be deposited on the area to be left uncoated is diverted therefrom by the exhaust stream.

From another aspect, the invention consists in apparatus for coating a specific surface area of an article with a particulate fusible coating material whilst leaving a different selected area uncoated, comprising delivery means arranged to direct a stream of the fusible material toward the specific surface area to be coated, means for supplying fluidized fusible material to said delivery means, and exhaust means adapted to create an exhaust stream, and so positioned that, in operation, the area to be left uncoated is subjected to the exhaust stream, whereby material that would otherwise be deposited on the area to be left uncoated is diverted therefrom by the exhaust stream.

The exhaust stream may comprise a stream of air which is directed across the surface areas to be left uncoated, to divert the particulate material from these areas. In this event the exhaust means may comprise one or more nozzles. Alternatievly, the exhaust means may comprise a vacuum hood or shoe positioned over the surface areas to be left uncoated, so that the exhaust stream is employed to draw off the particulate material, and thereby divert it from the latter areas.

It has been found that the results achieved are substantially enhanced by carrying the particulate material in a fluid stream exhibiting laminar flow characteristics; i.e. a stream having substantially parallel stream-lines, and substantially equal pressure and velocity at all points across the direction of flow of the stream.

The laminar flow of the fluidized material makes possible optimum positioning of the stream of material on the surface portions, and ensures that the material is distributed over the surface portions with the desired thickness and uniformity.

In order that the invention may be more readily understood, various embodiments will now be described with reference to the accompanying drawings, in which:

Figure 1 is a schematic top plan view of one embodiment of the coating apparatus of this invention;

Figure 2 is a cross-sectional view of the spray chamber of Figure 1, taken along line 2-2, showing the stator of an electric motor mounted therein for coating;

Figure 3 is similar to Figure 2 and shows the next sequential step in the coating of the stator;

Figure 4 is a detailed cross-sectional view of the stator, jig, conveyor, delivery nozzles, and vacuum shoes shown in Figure 3, taken along line 4-4;

Figure 5 illustrates apparatus similar to that of Figure 4, incorporating additional delivery nozzles and vacuum shoes positioned with the stator;

Figure 6 is a top plan view. illustrating apparatus adapted for coating the rotor of an electric motor; and

Figure 7 illustrates a different, plural nozzle embodiment of the invention for coating the rotor of an electric motor.

Referring to the drawings, Figure 1 is a schematic diagram of an apparatus embodying this invention, designed for the continuous selective coating of such unitary articles as the rotors and stators of electric motors. As shown, it consists of a conveyor 10 which travels in a horizontal endless loop about spoked wheels 12 and 14. One of the wheels may be power-driven while the other acts merely as a guide wheel.

After leaving load station 28, the conveyor passes through a pre-heat oven 16, a coating chamber 18, post-heat ovens 20 and 22, a quench chamber 24, and an unload station 26. The pre-heat oven, the post-heat ovens, and the quench chamber are of customary modular design and merely constitute heated or cooled open-ended chambers which surround a portion of the conveyor loop.

The coating chamber 18 has a unique construction, and as shown in Figures 2 and 3, consists of a hoodlike enclosure 30 with a vacuum exhaust vent 32 in its dome for evacuation of excess fluidized partcles, vapors, gases, and the like, from the chamber 34. The vent communicates with a return system 19 which scavenges the fluidized particles and returns them to the system.

The conveyor 10 travels through the centre of the chamber 34. Positioned periodically along its upper surface are V-shaped supports 36 which support the stator or the rotor as it is transported through the chamber, as shown in Figures 2, 3, and 4. These support members are welded, as at 38, onto separate links 40 of the conveyor. The particular size and shape

of the supports 36 may be selected to accommodate the parts to be coated most effectively.

Disposed within the support 36 is the unit intended to be coated, in the instance shown it is for an electric motor. In customary practice, the inner faces 44 of the pole pieces of the stator (see Figure 4) are not coated, while the winding coil apertures 46 formed in the body of the stator are coated with an insulating epoxy resin. Thus, wire subsequently looped about these pole pieces will be insulated from the body of the stator. Heretofore, uncoated areas on a coated piece required much hand operation, in complex masking or stripping steps, and these are avoided by the illustrated apparatus.

The apparatus consists primarily of at least one delivery nozzle 48, and exhaust means comprising a masking vacuum shoe 50 and/or masking air jet 57, as indicated in Figures 3 and 4.

The delivery nozzle 48 has an orifice 49 shaped so that a laminar flow will be imparted to the fluidized particulate coating material ejected, for even application of a uniform coating. In one preferred form, the orifice has two opposed convex lips, as shown in Figures 4 and 5, and other orifice shapes are also useful with certain coating materials. The vacuum shoe 50 comprises a hoodlike enclosure 51 preferably conforming in shape and dimension to the surface of the part to remain uncoated. The vacuum shoe 50 communicates, via a pipe 53, with an exhaust system. One or more air jets 57 may be directed at portions of the part to be coated, diverting the stream of coating material away from surfaces exposed to the air jet. Compressed air is supplied by a conduit 59 (Figures 2 and 3). As shown in Figure 4, the air jets 57 and vacuum shoes 50 in effect "mask", or divert coating particles from selected areas, such as the pole piece faces 44 of the stator 42.

The nozzles and vacuum shoes are supported by the structure shown in Figure 2. On the left of the Figure, one or more delivery nozzles 48 and air jets 57 join and are supported by pipes 53 and 59 respectively in a support member 54. The pipe 53 supplies fluidized particles through the member 54 to the nozzle 48. The member 54, pipes 53 and 59, jets 57, and nozzles 48 are advanced toward the stator 42 by a connecting rod 56 carried by a piston 58 slidable within a cylinder 60. A cage 64 eventually contacts and masks the side wall of the stator, and a chain support 66 bears the weight of the entire structural assembly and rotates the cage 64 and stator in successive quarter-turn stages to successively position the winding coil apertures and adjacent pole pieces of the stator to the delivery nozzle and vacuum shoes.

On the right side, a similar structure exists, except that here the plurality of vacuum shoes 50 actually enter the interior of the stator and position themselves overlying the pole faces 44. Each vacuum shoe 50 is exhausted via a vacuum pipe 53 mounted in a support member 68, vacuum being supplied to pipe 53 from pipe 69. The member 68 is supported and the shoe 50 is moved laterally into the stator by a connecting rod carried by a piston 72, slidable within a cylinder 74. A cage 78 contacts the side of the stator and supports the forward end of the assembly, and a chain support 80 bears the weight of the vacuum assembly and supporting structure and also acts to rotate the stator.

As will be apparent from a consideration of Figures 2 and 3, the portion of the conveyor in the coating station, and, therefore, the support 36, is lowered after the stator has been clamped between and supported by the cages 64 and 78, to provide clearance for the rotary movement of the stator 42.

Figure 5 illustrates a variation in construction of the delivery nozzle and vacuum shoe assembly which avoids the necessity for rotation of the stator. As shown, there is achieved by using four delivery nozzles and four vacuum shoes are used.

Figures 6 and 7 illustrate delivery nozzle and vacuum shoe assemblies adapted to coat the outer surfaces of a different article, such as the outside end walls of a rotor, which may be designed to fit into the stator shown in Figures 4 and 5. As shown, both embodiments include two chucks 82 for holding and rotating the rotor 84 by means of its shaft 85. One of the chucks is driven in rotation via a pulley belt assembly 86, whilst the other chuck merely acts as a follower and rotates freely in a pivot 88 (Figure 7).

In the Figure 6 embodiment, the shaft 85 of the rotor extends horizontally, and is grasped by the chucks and lifted from the support 90 only when the rotor is properly positioned at the coating station. Two spray nozzles 96 and 98 are directed to spray material against the upper side of the end walls of the rotor during rotation, and a vacuum nozzle or shoe 104 is utilized to prevent application of the sprayed fluidized particles upon the cylindrical wall or surface of the rotor. A pipe 108 supplies vacuum to the vacuum shoes.

In the Figure 7 embodiment, the shaft 85 of the rotor extends vertically instead of horizontally, the chucks 82 being carried by and movable with the conveyor, and, therefore, taking the place of the support 90 of Figure 6. The chucks serve to rotate the rotor when the latter is properly positioned at the coating station. Also in this

mbodiment, two additional spray nozzles 100 and 102, and an additional vacuum nozzle 106 and associated pipe 110, are provided.

To effect coating of a stator or rotor employing the apparatus hereinbefore described, both the delivery nozzles and vacuum shoes are used simultaneously. The delivery nozzle directs a stream of fluidized particles of synthetic plastics material, such as finely-divided polyethylene powder, to the heated part, while the vacuum shoes draw away any such material from the selected areas to be left uncoated. Thus, no physical masking is necessary.

Initially, the unit to be coated, such as the stator 42, is loaded onto the support member 36 of the conveyor at the load station 28. The belt then transports the uncoated stator through a pre-heat oven where it is heated to a temperature above the melting point of the plastics material to be used as a coat. In the usual situation, an epoxy resin is used and, in such instance, the stator is heated above the melting temperature of the resin.

The stator now enters the coating chamber 18. The vacuum shoe assembly 112 moves toward and into the stator through the action of the cylinder 74 and piston 72. The vacuum shoes 50 enter the cavity of the stator and position themselves immediately adjacent the pole faces 44. The cage 78 bears against the side of the stator and acts as a support, an aligning means for the vacuum shoes, and a mask for the side of the stator. Vacuum is now supplied via the vacuum supply pipe 69.

During or immediately following such positioning of the vacuum shoe assembly 112, the delivery nozzle assembly 114 moves forwardly via the cylinder 60 acting on the piston 58. The cage 64 bears against the opposite side of the stator. The delivery nozzle 48 is now positioned at the entrance to one of the winding coil apertures 46. A stream of fluidized solids, such as a finely powdered epoxy resin coating material suspended in a flowing stream of air, is now supplied to the nozzle, and the orifice 49 imparts a laminar flow to the stream as it is ejected. The stream of fluidized particles flows over the heated surface of the winding coil aperture 46 of the stator causing many of the particles of coating material to adhere to the surface of the heated stator. The excess particles are diverted by air jets 57 and drawn out and away from other surfaces of the stator, particularly the pole faces 44, via vacuum shoes 50 and exhaust vent 32. The drawn-off excess plastics material is recirculated to the supply system for re-use.

After the coating treatment, the stator is taken from the coating chamber 18 and transported to post-heat ovens 20 and 22 where additional heat is supplied to thoroughly fuse the adhered particles together. It is then quenched to room temperature in quench chamber 24. The stator is removed from the conveyor belt 10 at unload station 26. On inspection, it is found that only the winding coil apertures have been coated with epoxy resin.

The coating of rotors employs a similar technique, the only actual differences relating to the supporting jig and the particular configuration and number of delivery nozzles and vacuum shoes employed.

As shown in Figures 6 and 7, each vacuum shoe has sufficient flare to cover the width of the cylindrical surface of the rotor. Each delivery nozzle is similar in structure to those previously described. In this instance, however, they impinge fluidized plastics material against the side end walls of the rotor core while the rotor is being rotated. Thus, complete coating of the side walls is accomplished whilst no coating of the outer periphery occurs.

The technique hereinbefore described enables specific surface areas only of an article to be coated, in a specific predetermined pattern, by subjecting the surfaces to be coated to a stream of fluidized particles of the coating material, while retaining certain surfaces uncoated as required by subjecting them to a gaseous exhaust stream that diverts the particles of coating material, so that no premasking is necessary. More particularly, when a stream, preferably exhibiting laminar flow characteristics, of fluidized, particulate coating material is impinged upon certain surfaces of an article while a vacuum is simultaneously applied to those surfaces not to be coated, an even or uniform coating will result over the selected areas. No physical masking or subsequent coat removal operation being necessary.

It will be understood that the hereinbefore described coating apparatus and process, with modification, may be broadly applied to the coating of many kinds of articles, including wire, pipe and metal containers, in addition to the rotors and stators specifically described. The invention is uniquely adapted for the selective coating of articles on a volume production-line basis. The use of vacuum shoes permits utilisation of negative pressure or partial vacuum to provide a "masking" action by withdrawing the flowing stream of coating material from areas to be left uncoated. Jets of compressed gas, such as the air jets 57, similarly deflect the coating stream from areas to be left uncoated, and such jets may be used either alone or in conjunction with the vacuum shoes to provide masking of selected areas of the coated article.

Alternative conveying and material handling techniques may readily be used to carry the articles through the processing zones. For example, inclined ramps and chutes with timed gates may be used to dispense the articles to the coating station, and idler rollers may support the article, while it is rotated in the coating stream by a friction drive roller, until an ejector ram urges the coated article into a delivery conveyor to subsequent stations for further heating or the like.

Furthermore, the coating of motor parts may be partly completed before windings are added; the winding wire itself may be coated with a partially cured insulating coating, and after the windings are placed in position on the motor part, further coating and/or heat treatment provides final curing combined with curing and fused impregnation or encapsulation of the windings, forming a solid unitary construction.

The fusible coating material that can be used may be any of the thermoplastic or thermosetting resins now available. Typical examples of the thermoplastics are polyethylene, polypropylene, ethyl cellulose, cellulose acetate, cellulose propionate, cellulose acetate-butyrate, polyvinyl chloride, polyvinylindene chloride, polyvinyl acetate, the polyacrylates, the polystyrenes, the nylons, the fluorocarbons and mixtures. Example of thermosetting plastics and resins are the polyesters, the alkyds, the epoxies, and mixtures. When finely divided, powdered plastic coating materials are directed toward the molding surface in a flowing stream of gas, laminar flow is preferred and produces coatings of uniform thickness. The material may also be a molten metal, such as copper, lead, zinc, tin.

If desired, the method and apparatus hereinbefore described may be used in conjunction with electrostatic charges applied to create voltage differences between the surface areas to be coated and the delivery nozzles.

WHAT I CLAIM IS :—

1. A method for coating a specific surface area of an article with a particulate fusible material whilst another surface area is left uncoated, which comprises directing toward the specific surface area to be coated a stream of fluidized particles of the fusible material, depositing the fusible material on the specific area, and subjecting the area to be left uncoated to an exhaust stream, whereby material that would otherwise be deposited on the area to be left uncoated is diverted therefrom by the exhaust stream.

2. A method as claimed in claim 1, wherein the stream of fusible material has laminar flow characteristics.

3. A method as claimed in claim 1 or 2, wherein the surface area of the article which is to be coated is heated to a temperature not less than the melting point of the fusible material before being subjected to the stream of fusible material.

4. A method as claimed in claim 1, 2 or 3, wherein the exhaust stream comprises or includes a stream of gas directed over a surface area to be left uncoated, to divert the stream of fusible material therefrom.

5. A method as claimed in any preceding claim, wherein the atmosphere is exhausted in the zone of a surface area to be left uncoated to create the exhaust stream, thereby to draw fusible material away from said surface area.

6. A method as claimed in claim 5, wherein the exhausted gasses are recirculated to rejoin the stream of fusible material.

7. A method as claimed in any preceding claim, the article is heated to a temperature above the melting point of the fusible material, after coating, to level the coating on the coated surface area.

8. A method for coating specific surface areas of an article with a particulate, fusible, synthetic plastics material whilst other surface areas are left uncoated, comprising heating the article to a temperature above the melting point of the material, and impinging a flowing stream of fluidized particles of said material having laminar flow characteristics upon selected surface areas to be coated while simultaneously subjecting different selected surface areas to be left uncoated to a stream of compressed gas and/or to a reduction in atmospheric pressure.

9. The method of coating some areas of an article without coating other areas thereof, substantially as hereinbefore described with reference to the accompanying drawings.

10. An article having specific areas thereof coated with a synthetic plastics material by the method claimed in any preceding claim.

11. Apparatus for coating a specific surface area of an article with particulate fusible material whilst leaving a different selected surface area uncoated, comprising delivery means arranged to direct a stream of the fusible material toward the specific surface area to be coated, means for supplying fluidized fusible material to the delivery means, and exhaust means adapted to create an exhaust stream, and so positioned that, in operation, the area to be left uncoated is subjected to the exhaust stream, whereby material that would otherwise be deposited on the area to be left uncoated is diverted therefrom by the exhaust stream.

12. Apparatus as claimed in claim 11, wherein the delivery means comprises a nozzle capable of imparting laminar flow to the stream being ejected therefrom.

13. Apparatus as claimed in claim 11 or 12, including means to heat the article, before it is subjected to the stream of fusible material, to a temperature above the melting point of said material.

14. Apparatus as claimed in any of claims 11 to 13, wherein the exhaust means comprises a vacuum shoe adapted to be moved into a working position adjacent a surface area of the article to be left uncoated, and to reduce the atmospheric pressure in the region of the latter surface area.

15. Apparatus as claimed in any of claims 11 to 14, wherein an enclosure is disposed about the zone in which the article is positioned when being coated, means being provided to exhaust the atmosphere in the enclosure, thereby to reduce the atmospheric pressure about the article.

16. Apparatus as claimed in claim 15, wherein the means to exhaust the atmosphere in the enclosure communicates with recirculation means to feed diverted fusible material back to the delivery means.

17. Apparatus as claimed in any of claims 11 to 16, including a conveyor arranged to transport a succession of articles to and from the delivery and exhaust means disposed at a coating station, and means to move the delivery and exhaust means relative to an article when located at the coating station, to positions in which the delivery means is adjacent the surface areas to be coated on said article, and the exhaust means is positioned adjacent the surface areas to be left uncoated on said article.

18. Apparatus for coating specific surface areas of an article with a particulate fusible, synthetic plastics coating material whilst leaving different selected surface areas uncoated, comprising a delivery nozzle positioned to direct a stream of fluidized coating material having laminar flow characteristics toward the article, and one of, or both of, a vacuum shoe arranged to produce a reduction in atmospheric pressure and shaped to conform to said uncoated surface areas, and a jet arranged to eject a stream of gas, the shoe and/or jet, in operation, being movable into a working position adjacent surface areas of the article to be left uncoated to divert coating material therefrom.

19. Apparatus for coating specific surface areas of an article, constructed substantially as hereinbefore described with reference to Figures 1 to 4, or 5, or Figure 6, or Figure 7, of the accompanying drawings.

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London, W.8.
Chartered Patent Agents.

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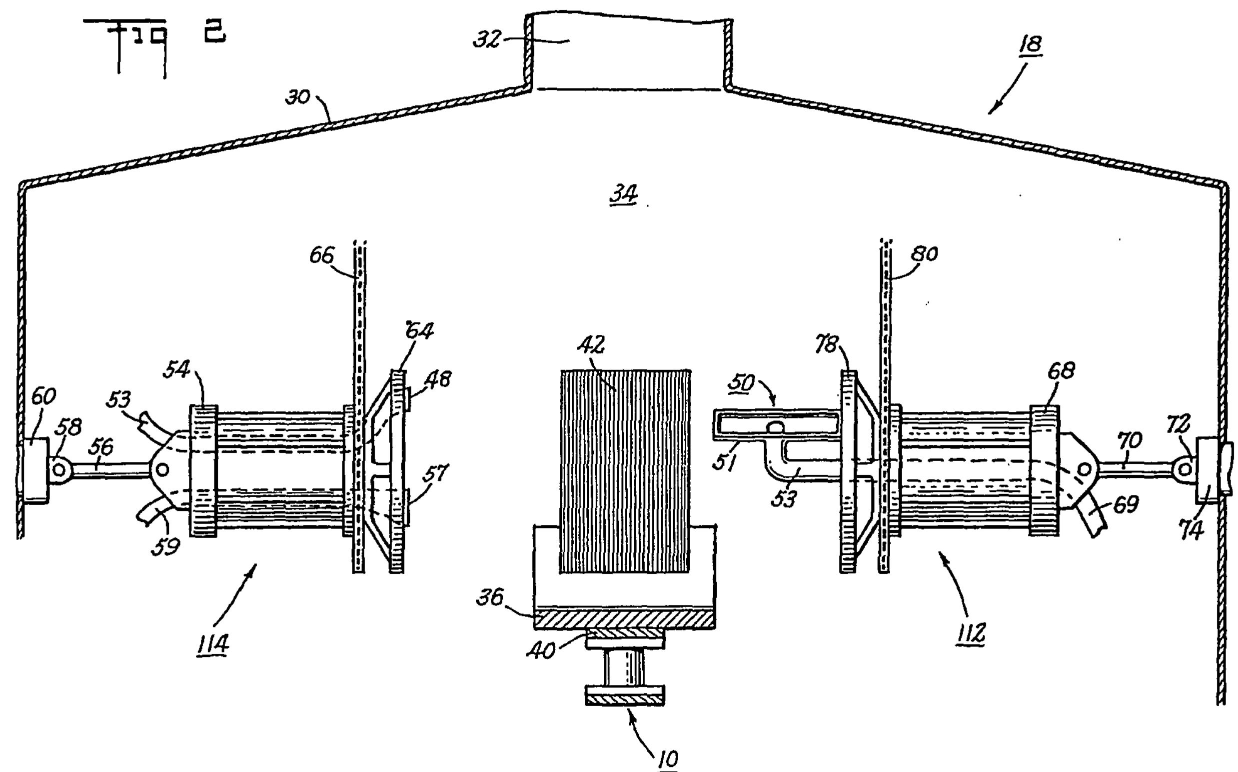
FIG 2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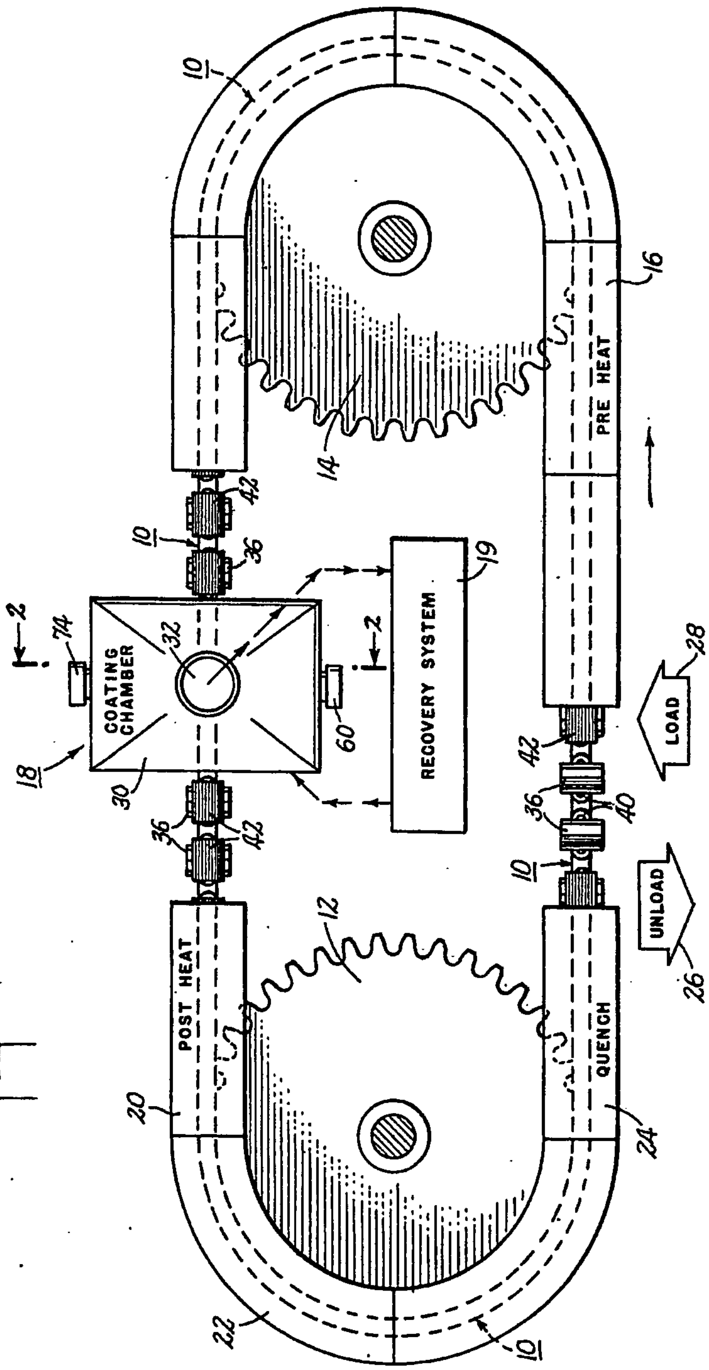

Fig 1

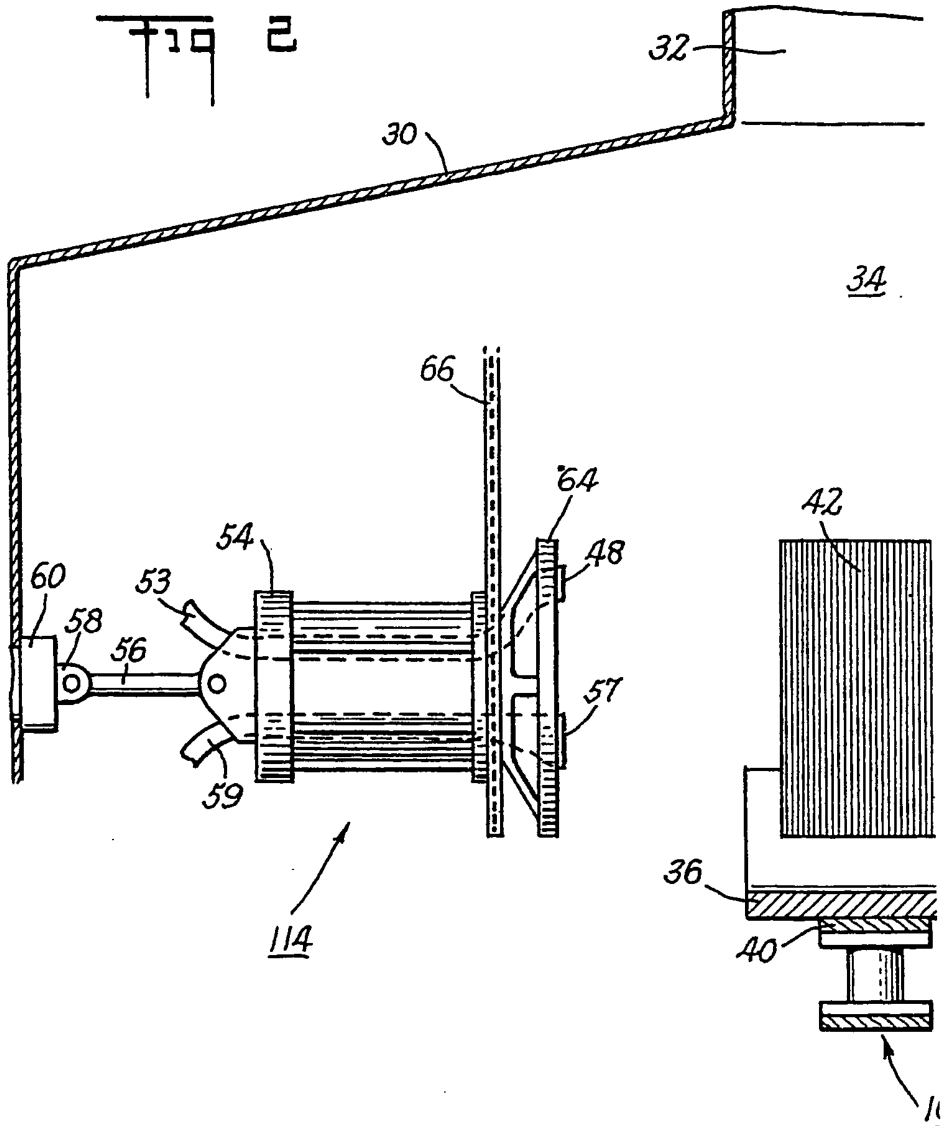

Fig 2

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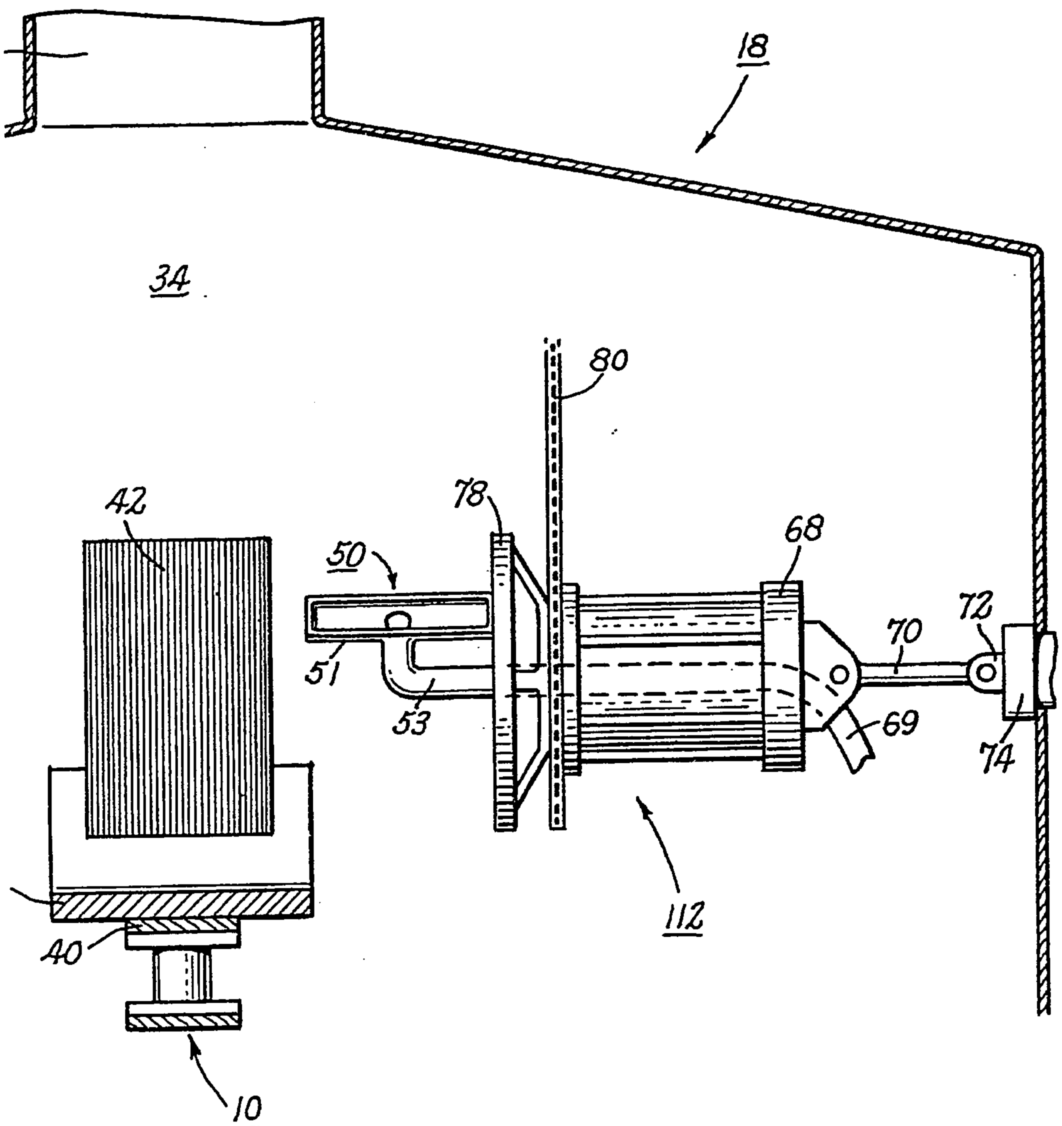

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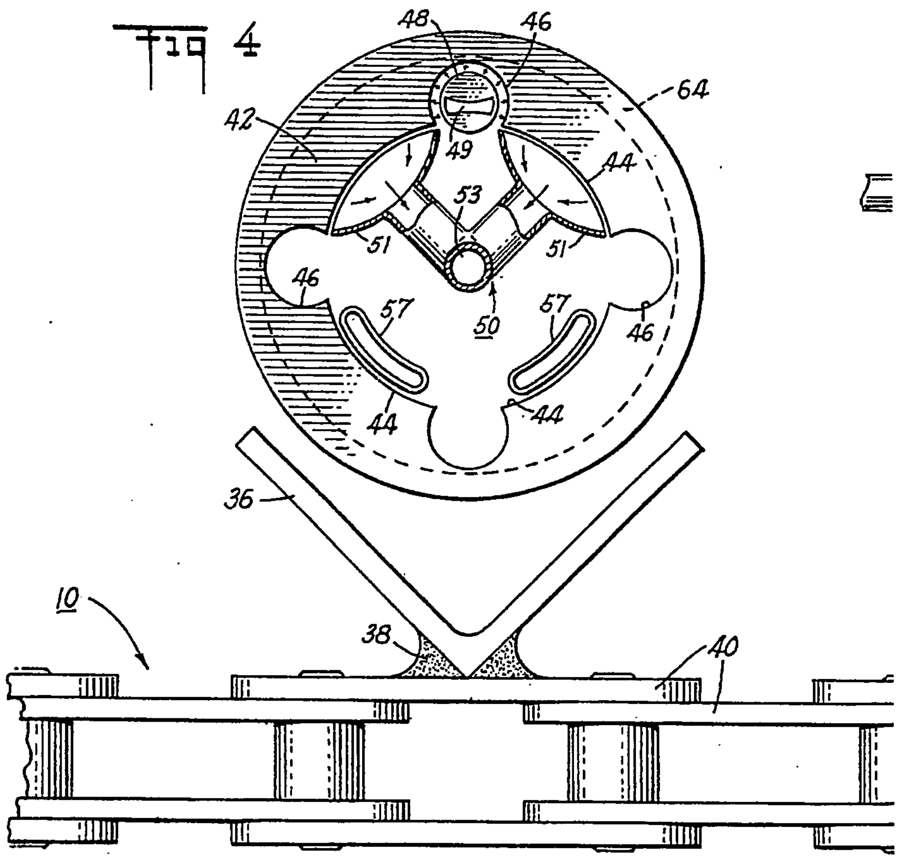
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Fig 5

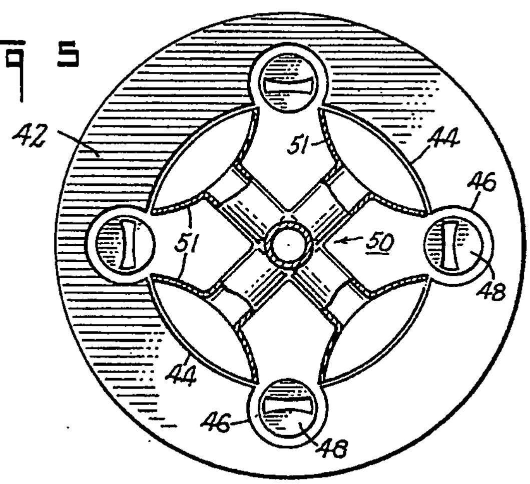
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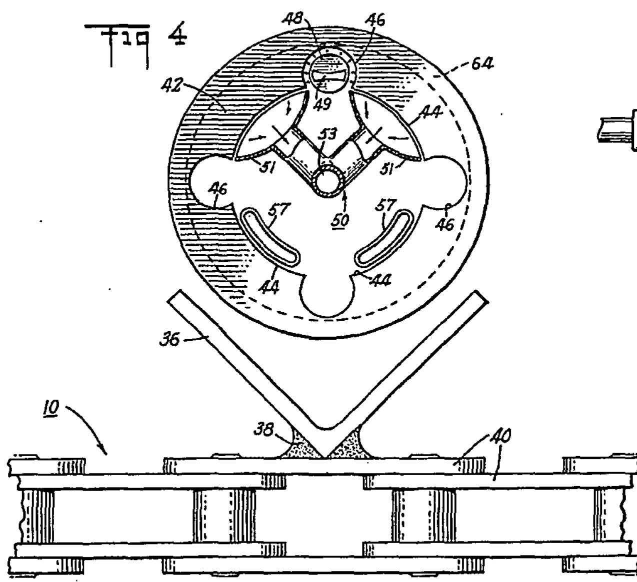
Fig 4



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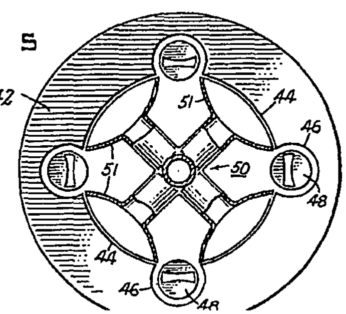


Fig 6

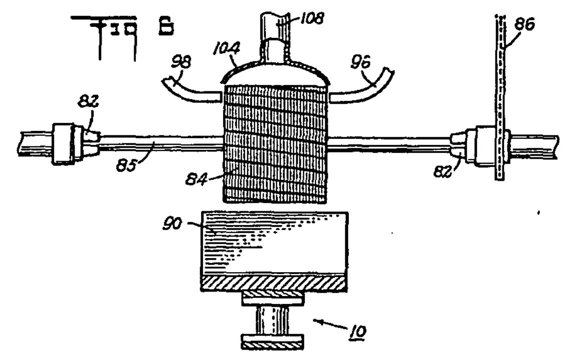
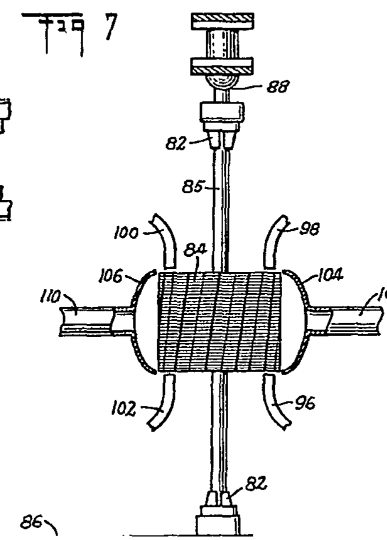


Fig 7



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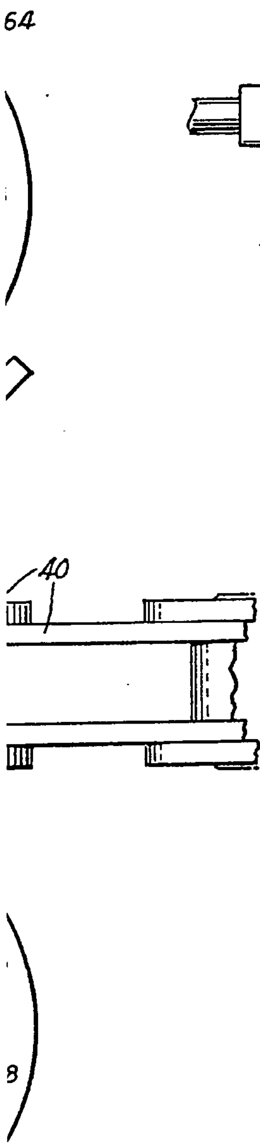

FIG 6

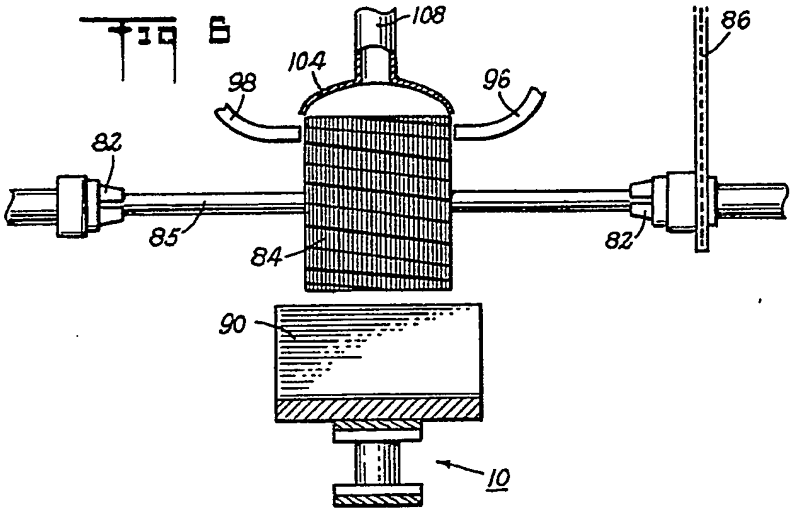

FIG 7

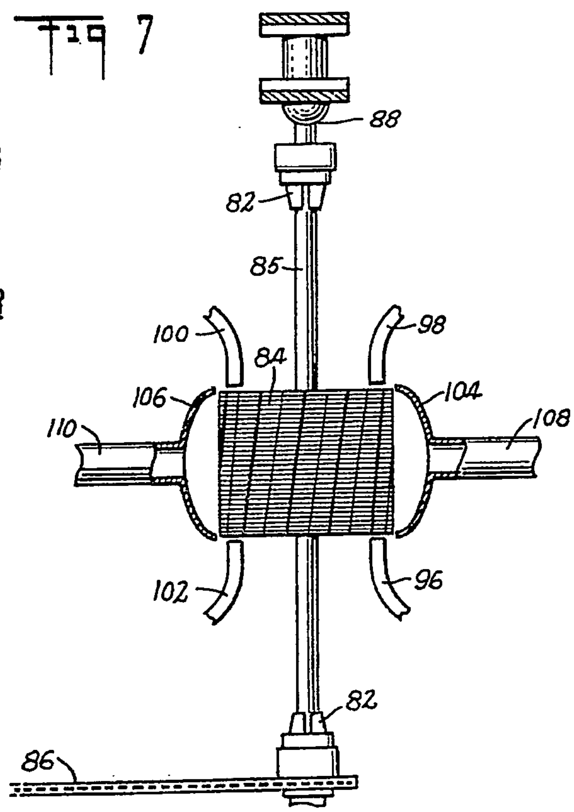

Fig 4

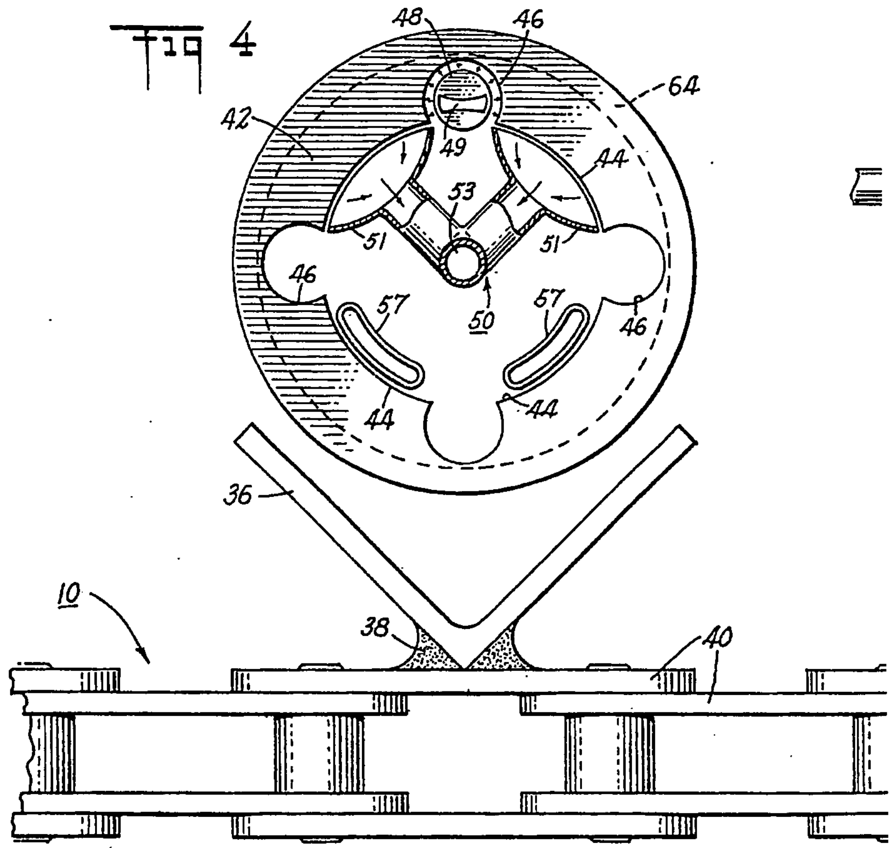
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Fig 5

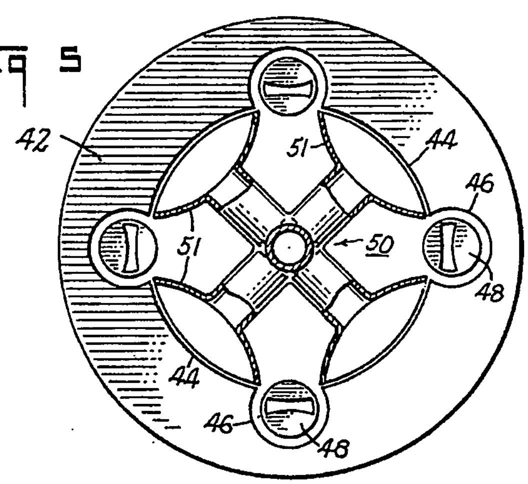
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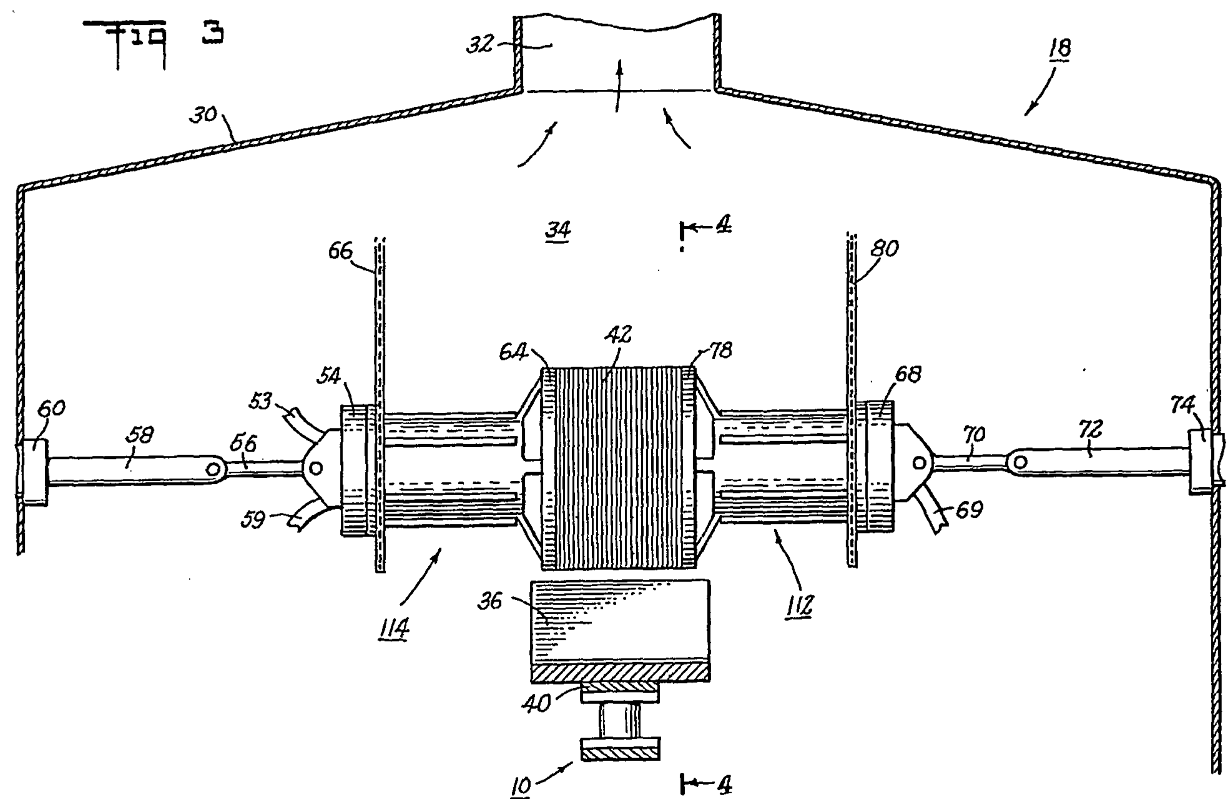
Fig 3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